Using Atlas 14 Data with NRCS/SCS Methodology for MnDOT projects

Dec, 2015

We all have a stake in **A** to **B**

Atlas 14 data with NRCS Methodology

- NRCS Hydrology methodology review
- Minnesota NRCS recommendation
- MnDOT recommendation
- Using Atlas 14 with HydroCAD

NRCS Hydrology

- NRCS – Natural Resource Conservation Service (formerly known as SCS – Soil Conservation Service) developed/support rainfall/runoff hydrology method
- NRCS uses to design small agricultural ponds, waterways and erosion control
- NRCS Hydrology methods typically used by MnDOT and most others in Minnesota when hydrograph analysis needed such as pond design
- Also used by MnDOT for peak flow for most culverts where drainage area is smaller than what recommended for StreamStats

NRCS Hydrology

▸ NRCS/SCS Rainfall/Runoff Hydrology Method
- Drainage Area
- Curve Number – based on land use and soil properties – proportion of precipitation that will runoff drainage area
- 24 hour design precipitation
- Time of Concentration – time for water to flow from furthest part of watershed to design point
- Rainfall distribution – intensity of precipitation over time (24 hours)
- Unit hydrograph – rate of flow vs time for the runoff from the watershed
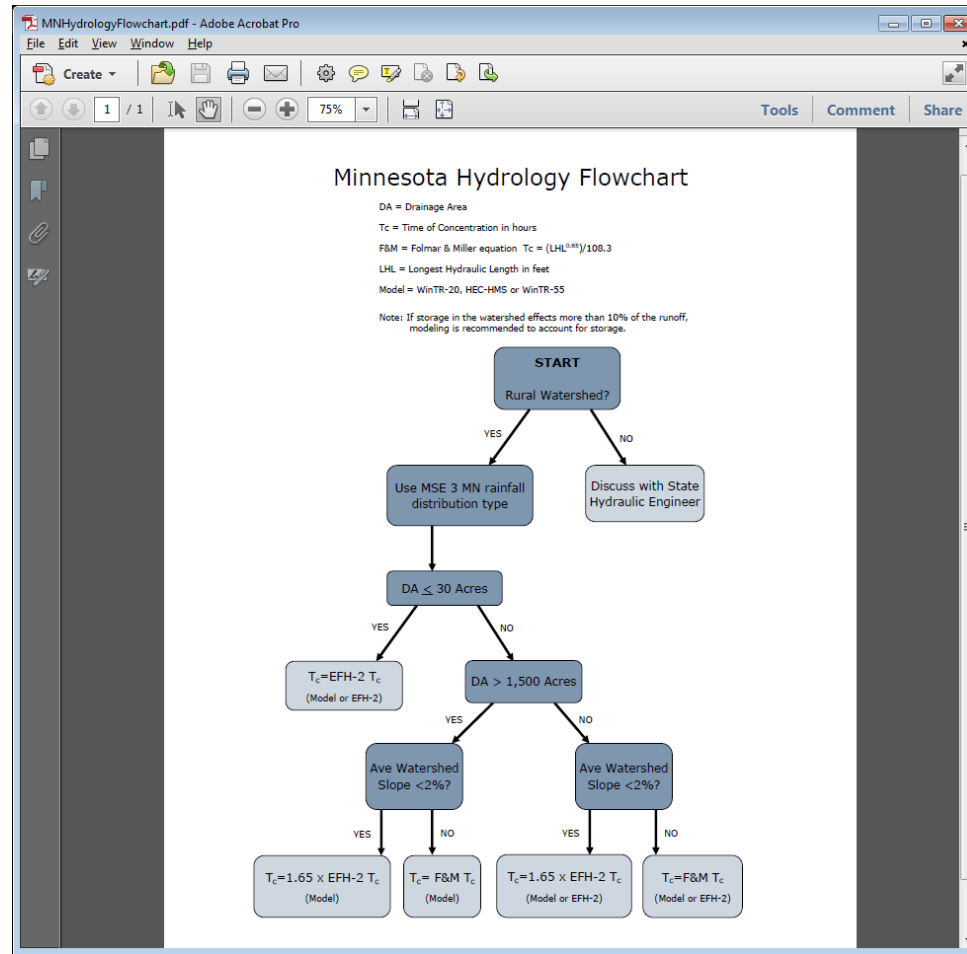
Minnesota NRCS Recommendation

▸ **Recommendations for NRCS Area and Field Staff for <u>NRCS projects for rural watersheds</u>**

<u>http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1270686&ext=pdf</u>

- Use Precipitation Depths from Atlas 14
- MSE 3 MN
  - MSE 3 rainfall distribution
  - Synthetic unit hydrograph with peak rate factor of 400
- Use Time of Concentration developed from Engineering Field Handbook (EFH2) or Folmar & Miller formula
- <u>Flowchart</u>

Minnesota NRCS Recommendation

MnDOT Application of NRCS Recommendation

▸ Tech Memo 15-10-B-02

▸ Urban Areas

- Stop using NRCS Type II Rainfall Distribution
- Use Atlas 14 Rainfall Depth – from PFDS server or NRCS County File
- Use MSE 3 or Atlas 14 Derived Rainfall Distribution
- Use SCS Typical Unit Hydrograph (peak factor 484)
- Use Time of Concentration formulas from Drainage Manual/TR-55
- Route flow (hydrograph analysis) where have storage

MnDOT Application of NRCS Recommendation

- Rural Areas
  - Stop using NRCS Type II Rainfall Distribution
  - Use Atlas 14 Rainfall depth
  - Use MSE 3 or Atlas 14 Derived Rainfall Distribution
  - Use standard dimensionless unit hydrograph with peak factor of 484 unless conditions on following slide met.
  - Route flow (hydrograph analysis) if significant storage, especially right upstream of crossing.

MnDOT Application of NRCS Recommendation

- Rural Areas – cont'd
  - Minnesota NRCS recommended methodology
    - MSE 3 rainfall distribution
    - Unit Hydrograph with peak factor of 400
    - Time of Concentration methods per NRCS flowchart
  - MN NRCS MSE 3 MN and Time of Concentration methodology may used for some rural drainage areas when all of the following conditions met:
    - Drainage area is rural
    - Drainage area is not steep
    - Predicted flows are consistent with historical observations at the site.

Using Atlas 14/NRCS resources in HydroCAD

Rainfall Depth – use either method below:

‣ Import rainfall depths from Atlas 14 PFDS server – helpsheet on web site

‣ NRCS County file – included with HydroCAD 10 Build 15 or higher – slides to follow

Rainfall Distribution – use either method below:

‣ Import rainfall distribution from Atlas 14 PFDS server – helpsheet on web site

‣ NRCS MSE 3 rainfall distribution included with HydroCAD 10 Build 14 or higher – slides to follow

Selecting NRCS MSE-3 Rainfall Distribution in HydroCAD
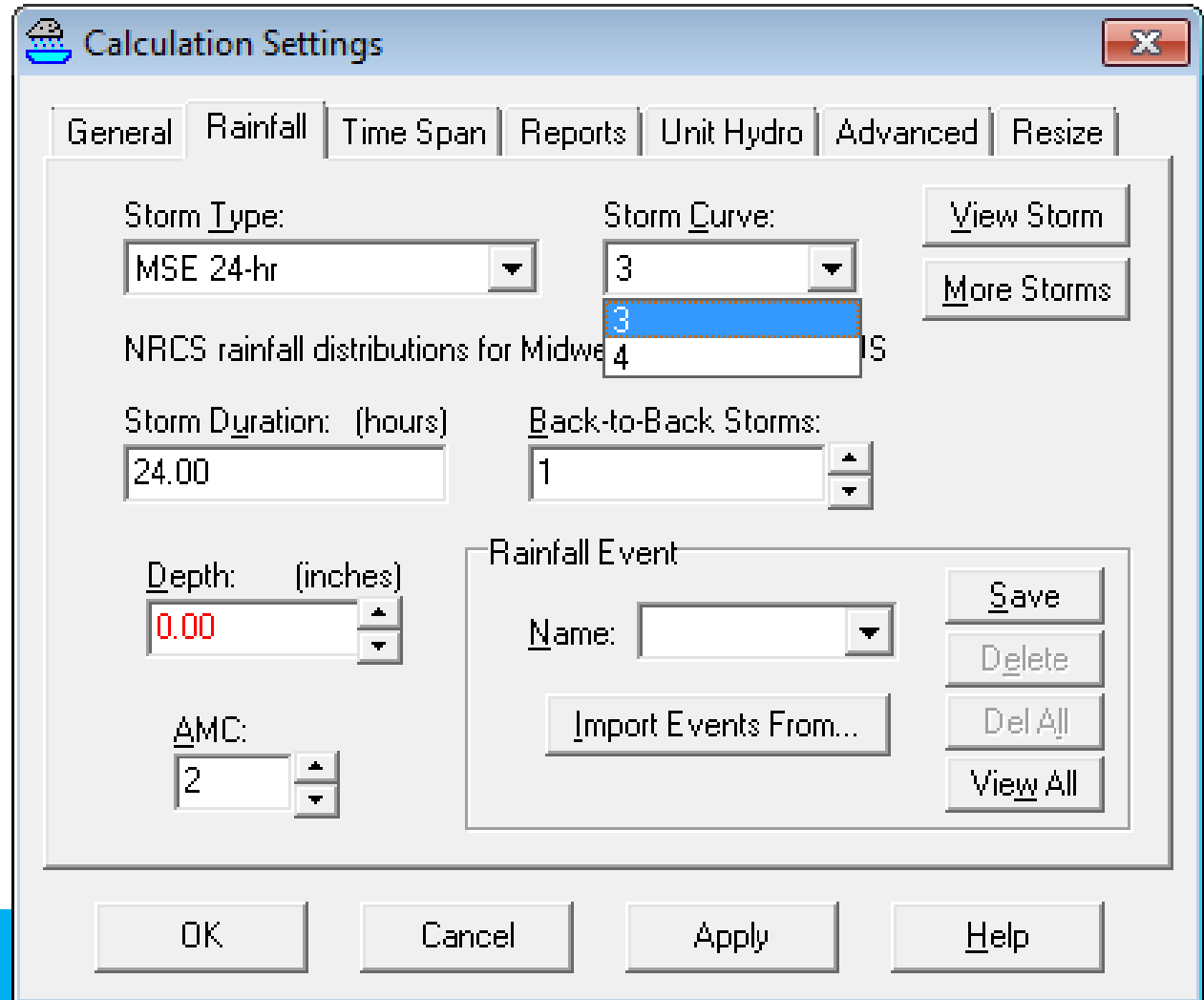
Select Calculation Settings Dialog and select Rainfall Tab

Select MSE 24-hr as Storm Type
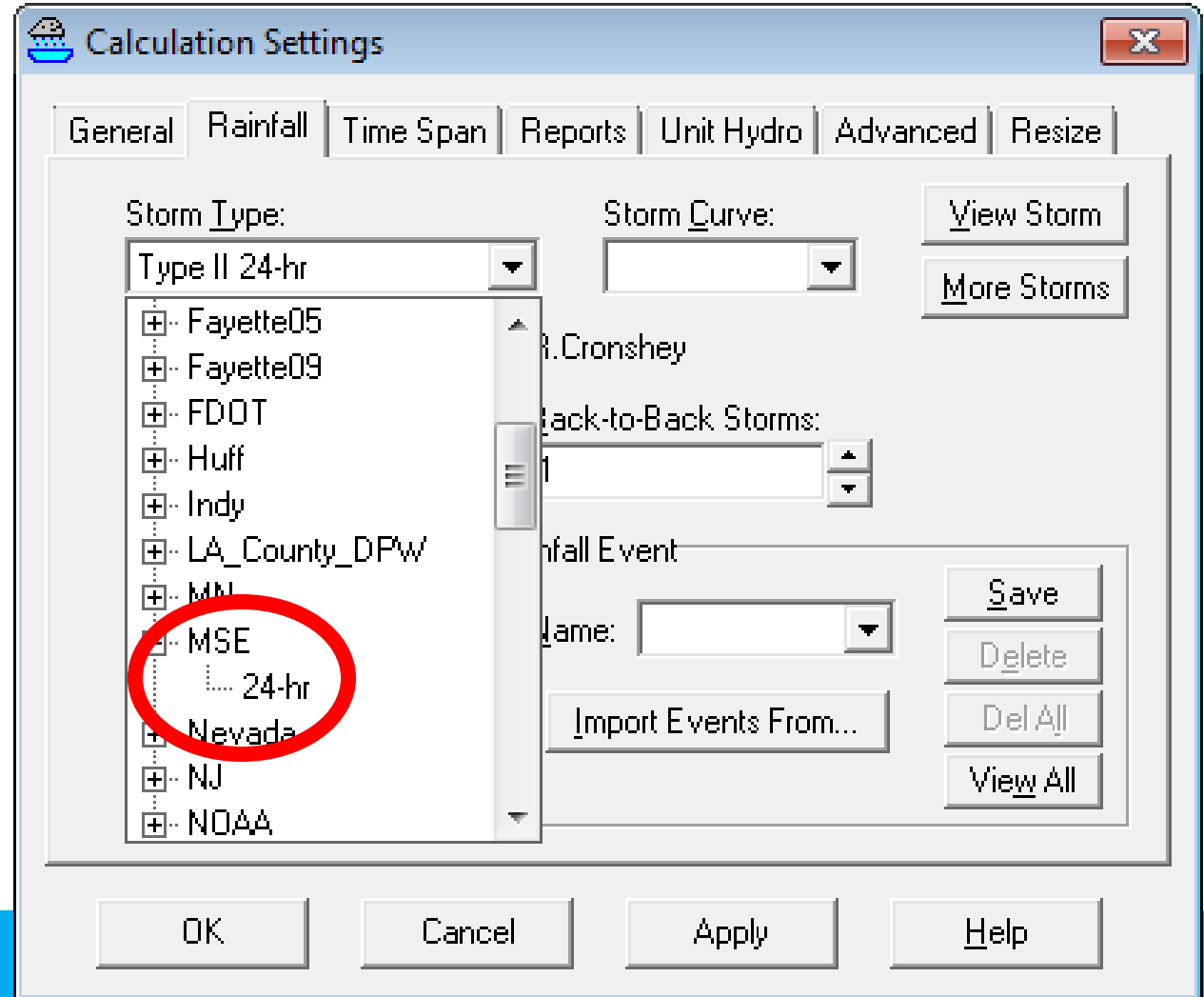
Selecting NRCS MSE-3 Rainfall Distribution in HydroCAD

▸ Then select Storm Curve 3

Select 24 hour rainfall depth from HydroCAD Lookup File

On Calculation Settings dialog/Rainfall Tab

➢ Go to Rainfall Event and click on **Import Events From** button

➢ Select Lookup Table
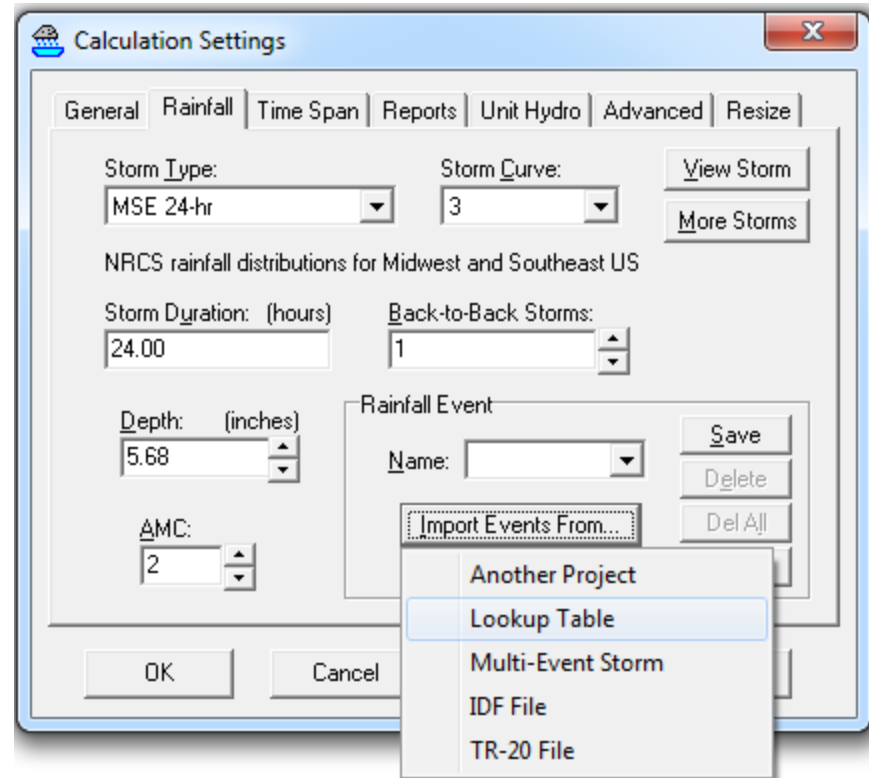
Select 24 hour rainfall depth from HydroCAD Lookup File

On Rainfall Event Lookup Table:

1. Select Event Lookup File **Atlas-14-Rain.txt**

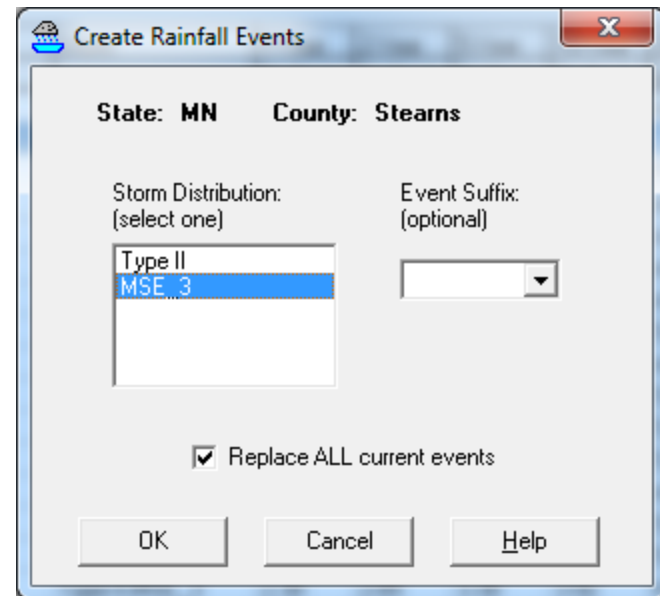2. Find State = MN

3. Scroll down and find county

4. Click on OK

Select 24 hour rainfall depth from HydroCAD Lookup File

Select **MSE 3** as Storm Distribution and OK

Data is from Minnesota NRCS County file and is the spatially averaged value for the county.

Using NRCS Recommendations in HydroCAD – MSE 3 Rainfall Distribution

Rainfall Distribution	Peak Flow
Atlas 14	162 cfs
NRCS – MSE3	167 cfs
SCS Type II	151 cfs

- Stearns County
- Drainage Area = 100 acres
- Tc = 64 minutes
- CN = 75
- 24 hour Rainfall = 5.68 in
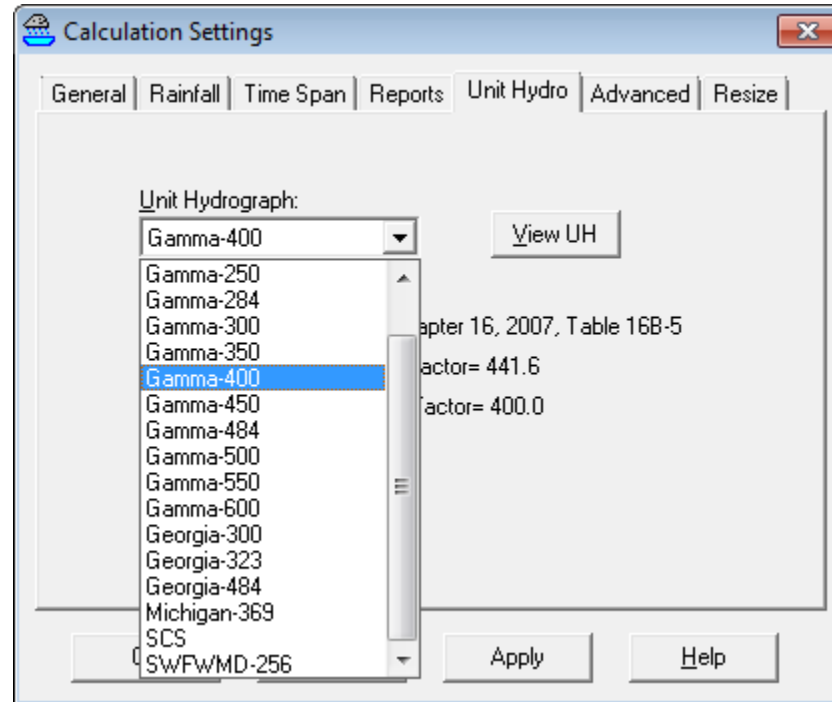
Minnesota NRCS – Unit Hydrograph
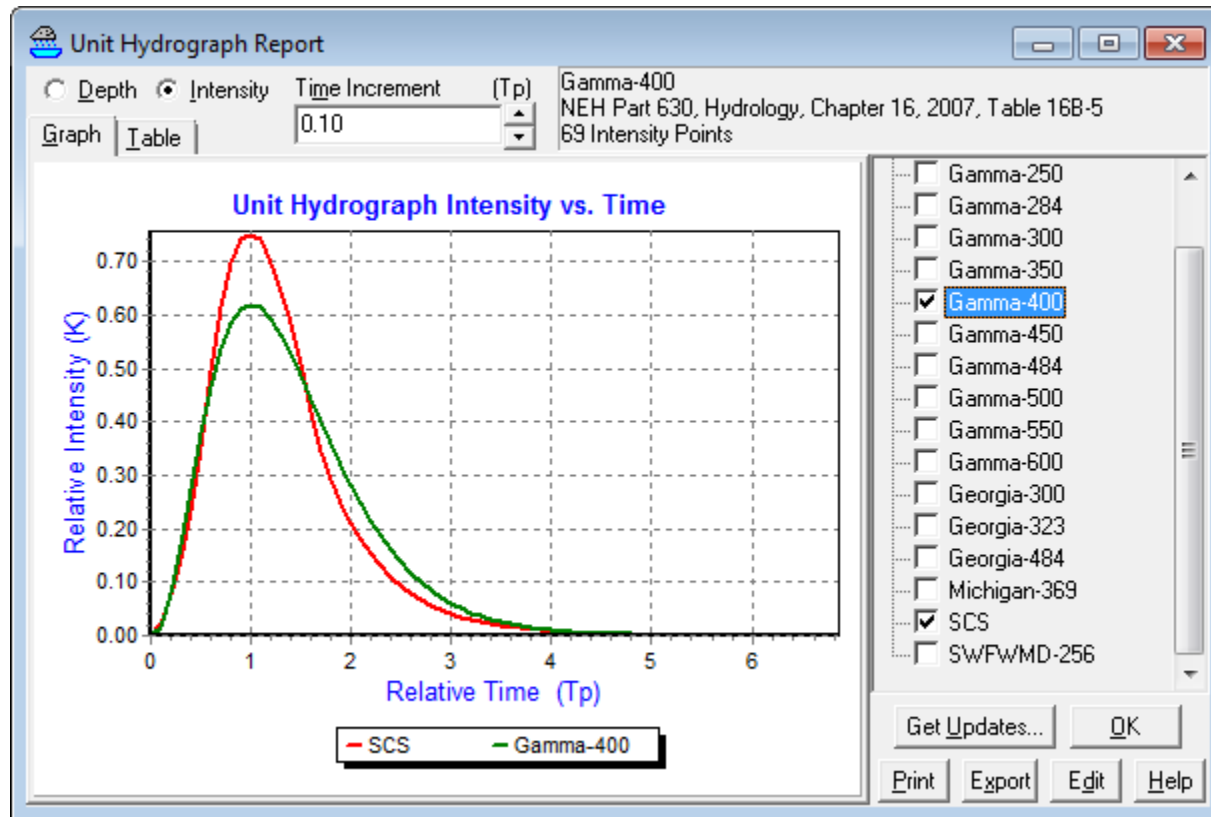
Selecting Peak Factor 400 Unit Hydrograph in HydroCAD

SCS is the default

Select peak factor 400 dimensionless unit hydrograph by going to

Settings > Calculation > Unit Hydro

Impact of Unit Hydrograph

Rainfall Distribution	Peak Flow – SCS Unit hydrograph (Peak Factor 484)	Peak Flow – NRCS Peak Factor 400
Atlas 14	162 cfs	
NRCS – MSE3	167 cfs	145 cfs MSE3 MN
SCS Type II	151 cfs	

- ▸ Stearns County
- ▸ Tc = 64 minutes
- ▸ CN = 75
- ▸ 24 hour Rainfall = 5.66 in

Review Options in Summary!

Using NRCS Methodology in HydroCAD – versions

- HydroCAD 10 build 15
  ◦ Includes county data file that includes Atlas 14 data for Minnesota counties
- HydroCAD 10 build 14 or higher
  ◦ Includes MSE 3 rainfall distribution
- HydroCAD 10 – build prior to 14
  ◦ Can import Atlas 14 rainfall distribution downloaded from PFDS server
  ◦ Includes unit hydrograph with peak factor 400
- HydroCAD version 9
  ◦ Can not import Atlas 14 rainfall distribution
  ◦ Need to develop a custom rainfall distribution for MSE 3 based on data from NRCS

Impact of Rainfall Distribution/Unit Hydrograph

‣ For Peak Flow method – most impact for areas with shorter Time of Concentration

‣ If route flow, especially if have significant amounts of storage, the unit hydrograph and rainfall distribution used have much less impact

Recommendations

▸ Stop using NRCS Type II rainfall distribution

▸ Use Atlas 14 derived distribution or MSE–3 distribution

▸ For urban watersheds – continue to dimensionless unit hydrograph with peak factor of 484 (default in HydroCAD)

▸ **Document what is used**

Recommendations

- Allowable to use NRCS Recommended Method for rural areas – MSE 3 MN
  - MSE 3 Rainfall Distribution
  - Unit Hydrograph with peak factor 400

- Use engineering judgment and continue to use typical SCS unit hydrograph (PF 484) where higher design flow justified:
  - Rural vs Agricultural
  - Climate Change resilience
  - No Storage
  - History of Flooding
  - Critical locations
  - Steepness/flashiness